Economics Letters 73 (2001) 51–55

economics letters

www.elsevier.com/locate/econbase

Habit formation in a monetary growth model

João Ricardo Faria[a,b,*]

[a]Department of Economics, University of New Hampshire, McConnell Hall, 15 College Road, Durham, NH 03824-3593, USA

[b]School of Social Sciences, University of Texas at Dallas, Richardson, TX, USA

Received 14 October 2000; accepted 29 March 2001

Abstract

This paper introduces the hypothesis of habit formation in consumption in the Sidrauski [Am. Econ. Rev. Papers Proc., 57 (1967) 534] model. A number of results are derived: (1) as in the Sidrauski model money is superneutral and the Friedman rule still provides the optimal quantity of money; (2) the demand for money in this model is greater than in the Sidrauski model; (3) the money demand reflects the habit persistence related to past consumption and the rate of time preference, and it is more sensitive to changes in inflation and nominal interest rates than the Sidrauski model.

Keywords: Consumption behaviour; Money demand; Money and growth

JEL classification: E41; D91; O42

1. Introduction

There has been growing interest on the effects of habit formation in consumption in the recent macroeconomics literature. The interest is associated with the fact that the standard representative agent models with intertemporally separable preferences have failed to explain several empirical observations. For example, Constantinides (1990) argues that habit persistence drives a wedge between the relative risk aversion of the representative agent and the intertemporal elasticity of substitution in consumption, which helps to explain the equity premium puzzle. Carroll et al. (2000) show that the introduction of habit formation in consumption in an endogenous growth model generates growth-to-saving causality. Fuhrer (2000) explores a monetary-policy model with habit formation for consumers and finds that the responses of both spending and inflation to monetary-policy actions are significantly improved.

*Tel.: +1-603-862-3328; fax: +1-603-862-3383.
E-mail address: jfaria@unh.edu (J.R. Faria).

0165-1765/01/$ – see front matter
PII: S0165-1765(01)00464-5

Nevertheless, the literature is far from reaching a consensus about the importance of the habit formation hypothesis. Studies of time-nonseparable preferences based on aggregate consumption data yield mixed conclusions about the importance of habit formation. On the one hand, Dunn and Singleton (1986) and Heaton (1993) find little evidence of habit formation in US aggregate monthly consumption data. On the other hand, Ferson and Constantinides (1991) and Braun et al. (1993) find significant amounts of habit formation for the American and Japanese consumption data, respectively. Recent evidence appears in Dynan (2000) who tests the hypothesis of habit formation in consumption with food consumption data. Her results yield no evidence that habits explain the evolution of consumption over time.

This paper aims at contributing to the theoretical part of this literature by extending the habit formation hypothesis to the neoclassical monetary growth model developed by Sidrauski (1967). The paper examines if consumption habits affect the classical results and implications of the Sidrauski model, such as the superneutrality of money, the money demand function, and the Friedman rule. The exercise is straightforward, since the modeling strategy of considering habit formation in consumption is composed of two elements. Firstly, a habit stock, determined by past consumption, is introduced in the utility function. Secondly, the time evolution of the stock of habits is taken as a dynamic constraint in the representative agent problem.

The paper is organized as follows. Section 2 presents the Sidrauski model extended with the habit formation in consumption. The steady state solutions of this model are contrasted with the basic Sidrauski model. The concluding remarks appear in Section 3.

2. The model

The model developed by Sidrauski (1967) considers real money balances (m) in the utility function and in the budget constraint of the representative agent. In the present model the individual cares not only about m and the instantaneous flow of consumption (c), but also takes into account his past consumption, captured by his stock of habits (h). The instantaneous isoelastic utility function proposed by Abel (1990) is adapted to introduce m:

$$U(c, h, m) = \frac{\left[(c/h^{\gamma})^{a} m^{1-a}\right]^{1-\sigma}}{1-\sigma} \tag{1}$$

where a is a positive parameter that lies in the unitary interval, σ is the coefficient of relative risk aversion, and $\gamma \in [0, 1)$ indexes the importance of habits. If $\gamma = 0$, then habit stock has no relevance, and the utility function reduces to the Sidrauski case. While if $\gamma = 1$, consumption relative to habit stock is very important.[1]

Following Carroll et al. (2000) it is assumed that the stock of habits is a weighted average of past consumption. The stock of habits evolves according to:

$$\dot{h} = \rho(c - h) \tag{2}$$

[1] It is worth stressing that in this framework, where all agents are equal, the aggregate consumption per capita is the same as the representative agent consumption, so the 'catching up with the Joneses' utility function is the same as in the habit formation model.

where ρ is a positive parameter determining the relative weights of consumption at different times. The smaller is ρ, the less important is consumption in the recent past.

The individual holds his real wealth (a) in the form of either real money balances or capital (k). His budget constraint is given by:

$$\dot{a} = [(r-n)a + w + x] - [c + (\pi + r)m] \tag{3}$$

where $a = m + k$, w is the real wage, r is the real interest rate, n is the rate of population growth, x is the government transfer, π is the inflation rate, the variables are in per capita terms.

The individual maximizes a discounted, infinite stream of utility:

$$\underset{c,\,m}{\mathrm{Max}} \int_0^\infty U(c,h,m)e^{-\theta t}\,\mathrm{d}t$$

subject to Eqs. (2), (3), and the usual no-Ponzi game condition:

$$\lim_{t\to\infty} a_t \exp - \left[\int_0^t (r_\tau - n)\,\mathrm{d}\tau \right] = 0 \tag{4}$$

where θ is the rate of time preference.

The current value Hamiltonian is:

$$H = U(c,h,m) + \psi\{(r-n)a + w + x - [c + (\pi + r)m]\} + \lambda\rho(c-h)$$

where ψ is the costate variable associated with Eq. (3) and λ is the costate variable associated with Eq. (2). It is important to notice that when $\rho = 0$ and $\gamma = 0$, the Sidrauski (1967) model is a special case of this model.

In order to solve the model two assumptions have to be made. Firstly, assuming competitive factor markets and that firms use constant returns to scale technology [$y = f(k)$, $f'(k) > 0$, $f''(k) < 0$], we have: $r = f'(k)$, and $w = f(k) - kf'(k)$.

Secondly, the lump-sum transfers are equal to the seigniorage from money issue: $x = \Omega m = (\pi + n)m$, where Ω is the rate of money growth.

The steady state solutions of this model, denoted by an asterisk, are the following:

$$f'(k^*) = \theta + n \tag{5}$$

$$c^* = f(k^*) - nk \tag{6}$$

$$c^* = h^* \tag{7}$$

$$m^* = \frac{(1-a)(\theta+\rho)c^*}{a(\pi + r)\theta}. \tag{8}$$

The system of Eqs. (5)–(8) is block recursive. Eq. (5), the modified golden rule, determines the steady state stock of capital (k^*). Then Eq. (6) determines the steady state consumption (c^*), followed by Eq. (7) which gives the equilibrium value of h, (h^*). Finally Eq. (8), the demand for money function, determines the steady state value of real money balances (m^*).

The block recursiveness of the steady state solutions above raises the first result of the paper: money is superneutral. One can see by Eqs. (5) and (6) that the money growth rate (Ω) does not affect the level of the steady state capital stock (k^*) and of consumption (c^*). Eqs. (5) and (6) are given by the same conditions as in the Sidrauski model, which are the same as in the nonmonetary Ramsey model.

The well known implication of the superneutrality result is the Friedman rule. That is, the steady state utility can be maximized by making real money balances large enough that their marginal utility equals zero. From the first order conditions of the model we have: $U_m(c, h, m) = \psi(\pi + r)$. So by making $U_m(c, h, m) = 0$, yields the Friedman rule: $r = -\pi$, which states that the individuals are satiated with money when the rate of return on money, given by the rate of deflation, is equal to the rate of return of capital, given by the real interest rate.

A number of results emerge from the comparison between the money demand derived from the model with habit formation and the money demand in the Sidrauski model. Note that the money demand in the Sidrauski model is given by:

$$m^s = \frac{(1-a)c^*}{a(\pi + r)}.$$

One can see that the money demand in the present model (Eq. (8)) is greater than the money demand of the Sidrauski model:

$$m^s = \frac{(1-a)c^*}{a(\pi + r)} < \frac{(1-a)(\theta + \rho)c^*}{a(\pi + r)\theta} = m^*.$$

This is due to the fact that the money demand in Eq. (8) reflects the habit persistence, captured by the term ρ, and the rate of time preference, θ. In addition, note that an increase in the rate of time preference decreases the demand for money, and that an increase in the habit persistence increases the money demand:

$$\frac{\mathrm{d}m^*}{\mathrm{d}\theta} = \frac{-(1-a)\rho c^*}{a(\pi + r)\theta^2} < 0$$

$$\frac{\mathrm{d}m^*}{\mathrm{d}\rho} = \frac{(1-a)c^*}{a(\pi + r)\theta} > 0.$$

Another important characteristic of this demand for money function is that the impact of inflation and the nominal interest rate are less than in the Sidrauski model:

$$\frac{\mathrm{d}m^*}{\mathrm{d}\pi} = \frac{-(1-a)a(\theta + \rho)\theta c^*}{[a(\pi + r)\theta]^2} < \frac{-(1-a)ac^*}{[a(\pi + r)]^2} = \frac{\mathrm{d}m^s}{\mathrm{d}\pi} \tag{9}$$

$$\frac{\mathrm{d}m^*}{\mathrm{d}(\pi + r)} = \frac{-(1-a)a(\theta + \rho)\theta c^*}{[a(\pi + r)\theta]^2} < \frac{-(1-a)ac^*}{[a(\pi + r)]^2} = \frac{\mathrm{d}m^s}{\mathrm{d}(\pi + r)}. \tag{10}$$

Eqs. (9) and (10) show that the demand for money derived in the model with habit persistence is more sensitive to changes in the monetary policy than the money demand derived from the Sidrauski model.

3. Concluding remarks

This paper introduces the hypothesis of habit formation in consumption into the Sidrauski model. A number of appealing results are derived. The superneutrality of money is proven to be robust even when past consumption is taken into account. As in the Sidrauski model, the Friedman rule still provides the optimal quantity of money. However, the money demand differs significantly from the Sidrauski model. In the present model, the money demand reflects the habit persistence related to past consumption and the rate of time preference. It is shown that the optimum amount of money demanded in this model is greater than in the Sidrauski model. One important consequence is that the money demand is more sensitive to changes in the inflation and in the nominal interest rates than in the Sidrauski model.

Acknowledgements

I would like to thank, without implicating, Nadima El-Hassan and Miguel Leon-Ledesma for useful comments.

References

Abel, A.B., 1990. Asset prices under habit formation and catching up with the Joneses. American Economic Review Papers and Proceedings 80, 38–42.

Braun, P.A., Constantinides, G.M., Ferson, W.E., 1993. Time nonseparability of aggregate consumption: international evidence. European Economic Review 37, 897–920.

Carroll, C.D., Overland, J., Weil, D.N., 2000. Saving and growth with habit formation. American Economic Review 90, 341–355.

Constantinides, G.M., 1990. Habit formation: a resolution of the equity premium puzzle. Journal of Political Economy 98, 519–543.

Dunn, K.B., Singleton, K.J., 1986. Modeling the term structure of interest rates under non-separable utility and durability of goods. Journal of Financial Economics 17, 27–55.

Dynan, K.E., 2000. Habit formation in consumer preferences: evidence from panel data. American Economic Review 90, 391–406.

Ferson, W.E., Constantinides, G.M., 1991. Habit persistence and durability in aggregate consumption: empirical tests. Journal of Financial Economics 29, 199–240.

Fuhrer, J.C., 2000. Habit formation in consumption and its implications for monetary-policy models. American Economic Review 90, 367–390.

Heaton, J., 1993. The interaction between time-nonseparable preferences and time aggregation. Econometrica 61, 353–385.

Sidrauski, M., 1967. Rational choice and patterns of growth in a monetary economy. American Economic Review Papers and Proceedings 57, 534–544.